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# Evaluating the Educational Impact of Studio-Based Design Methodologies in Architectural Courses

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## ABSTRACT

Architecture studios are essential in teaching design skills. Exploring how different design methodologies impact student performance helps improve education, fostering creativity, critical thinking, and better learning outcomes in architecture programs. The objective of the research is to examine the impact of various design methodologies on student achievement in architecture studios, identifying effective teaching approaches that enhance creativity, critical thinking, and overall performance in architectural education. The research involved 526 architecture students as participants. Data were collected using structured surveys to identify design methodologies and academic performance records. The software IBM SPSS Statistics version 17.0 was used to perform these statistical analyses including correlation coefficients, multiple linear regressions (MLR), ANOVA and paired t-test to examine the relationship between teaching methodologies and student achievement, providing insights into their impact on performance. Examined five factors: collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management. These factors were analyzed to determine their influence on student creativity, critical thinking, and overall achievement in architecture studio projects. The outcomes revealed a significant positive correlation among specific design methodologies and student achievement. Collaborative and iterative approaches showed the strongest impact on creativity and performance. Collaborative and iterative methodologies significantly enhance student achievement, highlighting the importance of effective teaching strategies in architecture studios.

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# 1. Introduction

Architecture education is a complex activity that involves creativity, technical knowledge, and problem-solving skills, all essential for students to succeed in the field. The most significant factor in influencing the outcomes of building learning is the design method used in the studio setting [1]. Architecture studios are the heart of architectural education, where theory is merged with practice, design skills are developed, and critical thinking abilities are developed. The design methodology is the process through which students are guided from conceptualization to analysis and realization of architectural projects [2]. The stage of an architectural student's career impacts the student for a lifetime in terms of design problem-solving and academic success. Design methodology in architecture is a systematic approach or framework that guides how architectural problems are defined, analyzed, and solved [3]. These can range from highly structured, prescriptive methods to fluid, open-ended processes that allow for more scope in terms of ideas and outcomes. The computer-aided design (CAD), building information modelling (BIM), and the latest design frameworks, also focus on sustainability, social responsibility, and technological developments [4]. These methodologies have been studied to be related to the performance of architecture students at university. Research shows that students' presentation and solution of design challenges influences their performance [5]. For instance, the adaptation resilience of students trained with the iterative approach of prototyping and feedback is higher [6]. Therefore, it is important to the work of educators and curriculum developers who seek optimum learning conditions and creativity while improving their students' performance to learn the details of various methodologies of designing. The architectural education begins to consider the impact that various methodologies of design impose on outcomes for students who focus on aspects such as creativity, critical thinking, or the capability to solve complex and real-world problems of design [7]. It also presents the idea that a student-centered and flexible approach to design can allow for exploring more diversified solutions and providing a greater understanding of the design process. Others can argue that structured methodologies provide a framework for a better understanding for students, guidance in their work and better problem-solving ability [8]. However, much of the literature found is very theoretical, and there exists a gap in empirical studies that link certain design methodologies to measurable outcomes in student achievement [9]. To investigate deeper into how instructor guidance, peer collaboration, and technology integration affect students' engagement with design processes and their academic performance. The ultimate objective is to make these findings useful in designing better teaching strategies and studio environments that promote more effective learning and achievement for students in architecture. Fig. (**1**) shows the design process involves research and analysis, ideation, and concept development, fostering creativity through collaboration via team discussions, peer feedback, and instructor guidance. It emphasizes critical thinking, problem-solving, and technical proficiency, culminating in project execution with prototyping, iterative improvements, and effective presentation of ideas. This holistic approach enhances learning outcomes, academic achievements, and career readiness for students [10].

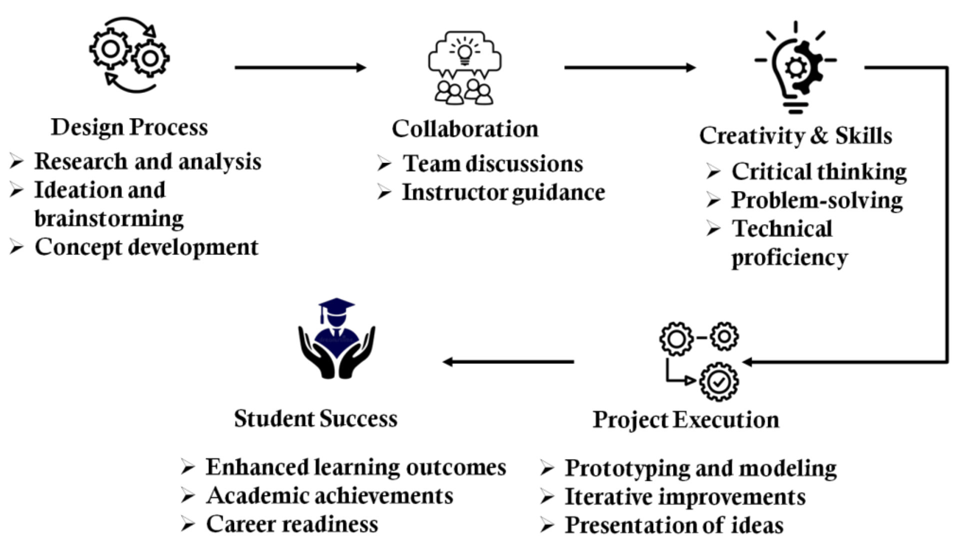



**Figure 1:** A Structured design process for students.

### 1.1. Objective

The objective of the research examines the impact of various design methodologies on student achievement in architecture studios. The aim is to identify effective teaching approaches that enhance creativity, critical thinking, and overall performance in architectural education.

### 1.2. Key Contributions

- A total of 526 architecture students participated in the research. Academic performance records and design techniques were gathered using organized questionnaires.
- Correlation coefficient, multiple linear regression (MLR), ANOVA and paired t-tests were used in the statistical analysis to examine the relationship between student achievement and instructional methods, providing insights into how these methods affect performance.
- The findings showed a strong positive relationship between particular design approaches and academic success.

The rest of the research was organized into the following sections: Section 2 explains the related works. Methods and Results were depicted in Sections 3 and4, and discussion and conclusion were given in Sections 5 and 6.

## 2. Related Works

Table **1** presents research on student achievement in architecture, outlining the year, data, objectives, and limitations, providing a comprehensive overview.

**Table 1: Overview of various articles related to student achievement in architecture studios.**

| Ref. | Aim | Method | Result | Limitation |
|---|---|---|---|---|
| [11] | To understand the impact of Virtual Design Studios (VDS) on education and student success. | Analyzed three years of data from the Open University's online design studio involving 3,000 students in a distance learning program. | Predicted positive academic and vocational effects from student engagement. | More detailed analyses are required to fully assess the learning outcomes. |
| [12] | To explore the impact of Business Simulation Games (BSGs) in flipped learning environments on learner achievement and higher-order thinking skills (HOTS). | Investigated the use of BSGs and their association with skill development in flipped classroom settings. | Found significant positive effects on learner achievement, engagement, and HOTS. | Limited focus on Jordanian university students; broader generalizations need further analyses. |
| [13] | To assess the response of Indian universities offering UG architecture degrees to the pandemic. | Analyzed perspectives of educators on the shift to online architectural education during the pandemic. | Summarized key insights into the challenges and opportunities of online education for architecture students. | Focused only on the educators' perspective; no direct student feedback included. |
| [14] | To evaluate the efficacy of blended learning in design studio pedagogy. | Gathered feedback from students and design instructors on a blended learning experience. | Found that applying design studio fundamentals in blended learning enhanced effectiveness and student satisfaction. | Limited data on long-term impacts of blended learning. |
| [15] | To create a foundational design course emphasizing experiential learning. | Developed a course focusing on turning abstract design concepts into physical spatial experiences. | Successfully enhanced students' problem-solving abilities and their understanding of the design process. | No comparison with traditional approaches was provided. |

**Table 1. contd….**

| Ref. | Aim | Method | Result | Limitation |
|---|---|---|---|---|
| [16] | To investigate how architectural studio environments influence student happiness. | Assessed the relationship between interior and outdoor environments in architectural studios. | Found that open, varied outdoor scenery had the most significant impact on student happiness. | Research only addressed outdoor environments; other influencing factors were not explored. |
| [17] | To align design studio education with sustainability frameworks. | Combined design studio instruction with sustainability theory lectures. | Raised students' awareness of sustainability and improved sustainable design approaches. | Limited discussion of practical applications beyond educational settings. |
| [18] | To examine the impact of self-regulated learning interventions in industrial design studios. | Implemented self-regulated learning interventions and analyzed their effects on students' performance. | Improved self-regulated learning methods and design performance among students. | Does not address variations in individual learning styles. |
| [19] | To adapt design education to the pandemic environment using health measures. | Utilized face masks and social distancing in design schools, focusing on desk critiques, social interaction, and studio structure. | Highlighted the importance of maintaining core studio components for students' learning during the pandemic. | Limited to short-term adaptations during the pandemic. |
| [20] | To establish the integrated role of architectural design studios as spaces for education and collaboration. | Examined collaborations among various stakeholders like architects, engineers, and masons. | Identified design studios as vital spaces for research and experimentation. | Lack of empirical data on collaboration effectiveness. |
| [21] | To assess correlations among subject-specific competencies in design studio courses. | Used statistical methods to evaluate correlation rates between categories. | Provided insights into the interconnectedness of subjects in design studio education. | Lacked detailed context on how findings can be applied in real-world scenarios. |
| [22] | To propose a sustainable architecture design studio (SADS) instructional model. | Conducted case analyses and proposed a comprehensive model for integrating sustainability concepts. | Found that students perform better when sustainability is incorporated at the project outset. | Limited validation of the proposed model in diverse educational contexts. |
| [23] | To analyze the integration of technology courses into design studios. | Critically examined document analysis techniques to study technology instruction in architectural education. | Highlighted the integrated role of technology in design studio pedagogy. | No assessment of technological advancements' long-term impacts on education. |
| [24] | To assist students in developing sustainable projects by integrating sustainability concepts in architectural design education. | Designed projects incorporating sustainability principles as a core element from the outset. | Found that student performance improved when sustainability was treated as a fundamental aspect of design projects. | Lacked long-term analysis of the effectiveness of this approach in professional practice. |
| [25] | To evaluate the teaching of technology in design studios and its integration in architectural education. | Applied document analysis techniques and examined case analyses on the integration of technology courses. | Identified key functions of technology in enhancing architectural education and design studio practices. | Limited focus on case analyses; broader generalization required. |

The studies summarized in Table **1** provide foundational insights that underpin the current research. They collectively highlight the centrality of feedback, collaborative learning environments, and student engagement in driving academic achievement. By integrating findings from these works, this study builds a comprehensive framework that connects established pedagogical principles with emerging digital instructional strategies.

# 3. Methodology

The method included a survey of 526 architecture students to recognize design methodologies and educational performance. The data were analyzed using correlation coefficient, MLR, ANOVA and paired t-tests to recognize the association between teaching methods and student achievement. Five factors were studied: collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management. Statistical analyses identified significant correlations and predictors of success, with collaborative and iterative approaches showing the strongest impact on student creativity and performance. Fig. (**2**) depicts the flow of the research.

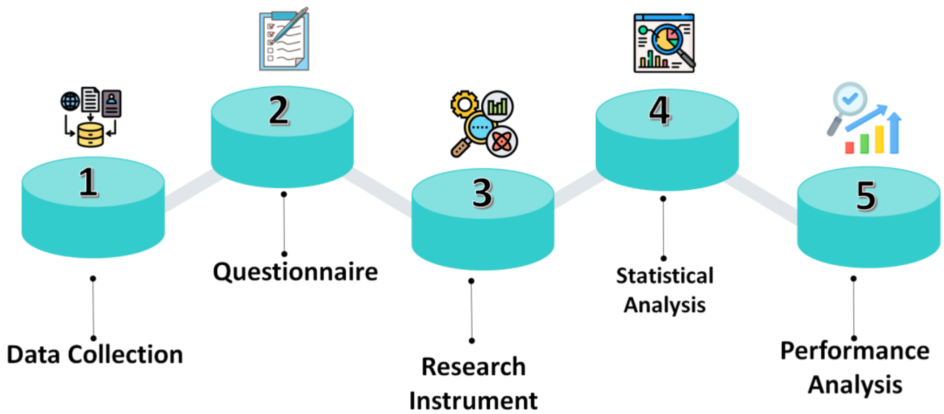



**Figure 2:** A comprehensive examination of research flow.

### 3.1. Data Collection

The dataset for the research consisted of 526 architecture students, with data collected through structured surveys and supplemented by their performance records, which are further supplemented by their performance records. Surveys produced the design methodologies carried out in the studio, whereas the performance records derived as to what has been attained by the students. These variables are connected to five major factors of this dataset that encompass collaborative learning, iterative processes, instructor feedback, problem-solving, and time management.

### 3.2. Questionnaire

The questionnaire was constructed to collect data on various key factors believed to affect student performance, such as collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management. The research questionnaire aimed to establish whether there is a relationship between design methodologies and the success of students in architecture studios. 526 architecture students were also asked questions that best reflected their experiences with other design methodologies used in their studio courses. Questions were designed that would capture the extent of application for each methodology used and how the students believed it had impacted their creative thinking, critical thinking ability, and overall achievement when working on architectural design projects. In addition, the questionnaire gathered records of academic performance data to give a full representation of how these methodologies translated into real student results. The survey questionnaire is provided in Table **2**.

### 3.3. Research Instrument

Students' perception of several key factors with a Likert scale questionnaire made use of a structured survey instrument to measure the effects of different design methodologies on student learning in architecture studios. Students rate agreement on a series of statements with five principal factors: collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management. For collaborative learning, statements address the belief that teamwork enhances creativity, fosters innovative solutions, and improves understanding of design principles. For instructor feedback, the statement evaluates whether students find the instructor's guidance helpful for improving their work, fostering critical thinking, and providing growth opportunities. Regarding problem-solving skills, the statements focus on how the design methodologies encourage critical thinking and enhance students' capacity to handle complex design problems. Finally, it deals with the time management aspect, students believe that the methods help manage time, ensuring timely completion of projects, and even providing quality projects. The tool asks the participant to rate each statement on a 5-point Likert scale. It aims to test the most effective teaching methods that maximize creativity, critical thinking, and overall performance in architectural studio courses.

**Table 2: Assessments of questionnaire.**

| S. No. | Student Achievement in Architecture Studios Survey Questionnaire |
|---|---|
| 1 | How familiar are you with various design methodologies used in architecture studios? |
| 2 | To what extent do people believe different design methodologies impact your academic performance in architecture studios? |
| 3 | How significant do individuals think collaborative learning is in shaping creativity and problem-solving skills in architecture studios? |
| 4 | Have you ever received formal training or instruction specifically on design methodologies in architecture education? |
| 5 | What teaching methods or resources do you find most helpful in enhancing your understanding and performance in architecture design tasks? |
| 6 | How do you evaluate the impact of iterative design processes on your creativity and overall performance in architecture studios? |
| 7 | How aware are you of the role that instructor feedback plays in shaping your design approach and academic achievement in architecture studios? |
| 8 | To what extent do people believe effective time management influences the quality of their work and their success in architecture studios? |
| 9 | How important do individuals think problem-solving skills are for achieving success in architecture studio projects? |
| 10 | What strategies do people believe could improve teaching practices and student achievement in architecture design studios? |

## 3.4. Statistical Analysis

These experiments were performed under IBM SPSS Statistics version 17.0, which gave this statistical functionality to compare among approaches, identify the importance of key success factors, and compare performance before and after implementation. The results obtained are important in showing high-quality teaching methods, especially collaborative and iterative methods, through which students' creativity improves, critical thinking as well as overall academic performances in architectural studios are enhanced.

### *3.4.1. Correlation Coefficient*

To measure the strength and direction of the connection among design methodologies (such as collaborative learning, iterative processes, etc.) and student achievement. A positive correlation indicates that as the use of certain design methodologies increases, student achievement also improves. The coefficient helps quantify how strongly the teaching methods influence creativity, critical thinking, and overall performance in architecture studios.

### *3.4.2. Multiple Linear Regressions (MLR)*

Identify key predictors of student success by examine into how different design methodologies were significant contributors to student achievement. MLR was used to determine the association between the five factors: collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management in student achievement. From regression analysis, it emerged that collaborative and iterative methodologies are the strongest predictors of student achievement, thus implying that these methodologies enhance student performance significantly.

### *3.4.3. ANOVA (Analysis of Variance)*

To determine the differences in student achievement based on a range of design approaches. One-way ANOVA was utilized to compare the achievement scores among different teaching methodologies that were based on factors, such as collaborative learning, iterative processes, instructor feedback, problem-solving, and time management. A difference in achievement scores among different teaching methodologies was reported; therefore, it indicated that some teaching approaches had more impact on student performance than others.

### *3.4.4. Paired T-tests*

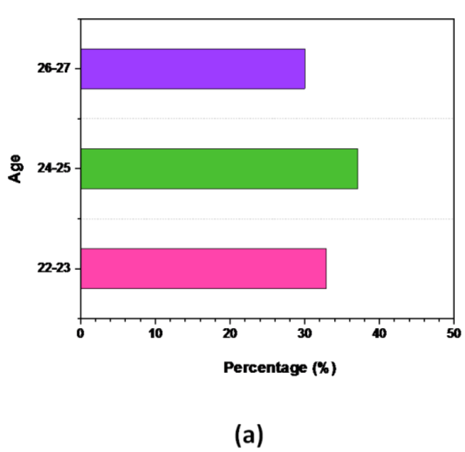
Compare the students' performance before and after applying particular design methodologies. To identify whether there is a statistical improvement in students' performance. Paired t-tests were conducted to compare before-and after-implementation scores for student performance across different design methodologies. Paired t-tests reported that for collaborative and iterative design methodologies, there was an improvement in student performance; this suggested that these two methodologies improve student achievement positively.

# 4. Result

The findings showed a significant positive correlation between student success in architectural studios and certain design techniques. Collaborative learning and iterative processes were the most influential factors for improving student creativity and overall performance. Statistical analysis, including correlation coefficient, MLR, ANOVA and paired t-test indicated significant differences in student achievement between different teaching methods, with collaborative and iterative approaches as the most effective. This analysis further ascertained collaborative learning, iterative processes, and instructor feedback as important predictors of students' success. These results point to the need for efficient teaching strategies that focus more on the areas of promoting collaboration and iteration for bettering the students' performance in architectural education.

## 4.1. Demographic Characteristics of Participants

The demographic characteristics of the sample (N=526) are as follows: In terms of age, 32.9% are between 22-23 years old, 37.1 % are among 24 and 25 years old and 30.0% are between 26 and 27 years old. Education level presents that 21.4% have completed high school with 54.3 % holding a bachelor's and 24.1% having a master's and above. Employment status presents with 60.0%, indicating full-time employment, 24.3% part-time, and 15.5% unemployed. Regarding marital status, 70.0% are single, 27.1% are married, and 2.9% are divorced. Work type comprises 34.3% holding professional/managerial occupations, 24.3% clerical/administrative, 15.7% service occupations, and 25.7% are self-employed and running a business. There is also flexibility at work with 41.4% having flexible scheduling and 58.6% fixed schedules. Fig. (**3**) and Table **3** display demographic characters.



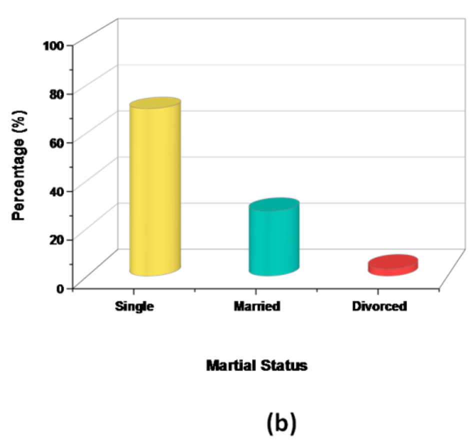




**Figure 3:** (**a**) Representation of age (**b**) Representation of marital status.

**Table 3: Participants of the demographic characteristics.**

| Demographic Characteristics | N=526 (%) | Count |
|---|---|---|
| **Age (years)** | | |
| 22-23 | 32.9% | 173 |
| 24-25 | 37.1% | 195 |
| 26-27 | 30.0% | 158 |
| **Education Level** | | |
| High School | 21.4% | 113 |
| Bachelor's Degree | 54.3% | 286 |
| Master's Degree or Higher | 24.1% | 127 |
| **Employment Status** | | |
| Full-time | 60.0% | 316 |
| Part-time | 24.3% | 128 |
| Unemployed | 15.5% | 82 |
| **Marital Status** | | |
| Single | 70.0% | 368 |
| Married | 27.1% | 143 |
| Divorced | 2.9% | 15 |
| **Job Type** | | |
| Professional/Managerial | 34.3% | 180 |
| Clerical/Administrative | 24.3% | 128 |
| Service | 15.7% | 83 |
| Self-employed/Business | 25.7% | 135 |
| **Work Flexibility** | | |
| Flexible Schedule | 41.4% | 218 |
| Fixed Schedule | 58.6% | 308 |

## 4.2. Correlation Coefficients

Correlation coefficients are statistical measures to calculate the power and direction association between two factors. The size of the correlation coefficient indicates the power of the connection. The closer the coefficient is to 0, the weaker the relationship. A coefficient of 1.00 or -1.00 indicates a perfect linear relationship. The main purpose of correlation coefficients is to recognize and evaluate the degree to which variables are connected, helping researchers determine whether change in one variable correspond to change in another. A positive correlation might indicate that higher quality teaching is associated with better student achievement, while a negative correlation could suggest that certain teaching practices cannot lead to desired academic outcomes. By analyzing these correlations, educators and researchers can gain insights into which factors most influence student success and adjust their strategies accordingly. Table **4** shows correlation coefficients between various factors related to the educational process.

Using correlation coefficients, first gather data on the factors of interest. In this case, data on education methodologies (e.g., collaborative learning, instructor feedback) and student outcomes (e.g., creativity, critical thinking, and overall achievement) would be gathered, potentially through surveys, performance assessments, or observational recordings. The data is then analyzed using statistical software, applying methods such as Pearson's correlation coefficients depending on the data. This analysis provides insights into which design methodologies have the strongest impact on enhancing student achievement in architecture studios.

**Table 4: Collaborative learning and associated skill correlations.**

| Factors | Collaborative Learning | Iterative Processes | Instructor Feedback | Problem-Solving Skills | Time Management |
|---|---|---|---|---|---|
| Collaborative Learning | 1.00 | 0.72 | 0.65 | 0.78 | 0.60 |
| Iterative Processes | 0.72 | 1.00 | 0.68 | 0.80 | 0.63 |
| Instructor Feedback | 0.65 | 0.68 | 1.00 | 0.75 | 0.58 |
| Problem-Solving Skills | 0.78 | 0.80 | 0.75 | 1.00 | 0.70 |
| Time Management | 0.60 | 0.63 | 0.58 | 0.70 | 1.00 |

### 4.3. Multiple Linear Regression Analysis (MLR)

The relationship between various design techniques and student achievement in architectural studios was examined using the MLR. The MLR performs better when the research aims to pinpoint how several independent factors affect a single dependent variable. The effect of each variable on the result, or student accomplishment, is represented by B. A positive coefficient indicates a correlation between rising student accomplishment and rising predictor variable levels. The variability or uncertainty of the coefficient estimate is measured by the SE. Smaller standard errors indicate more accurate estimates. The T-value is the ratio of the B to its standard error. A higher correlation between the predictor and the variable is shown by higher t-values. P-value indicates that the coefficient deviates from zero. As it stands, a p-value of 0.05 typically indicates statistical importance; however, Table **5** equally shows this relative power, wherein different teaching approaches can identify teaching strategies that are more important for creativity and creative critical thinking in architectural education.

**Table 5: Regression analysis of factors influencing learning outcome.**

| Variable | Coefficient | Standard Error | T-value | P-value |
|---|---|---|---|---|
| Collaborative Learning | 0.35 | 0.08 | 4.38 | 0.001 |
| Iterative Processes | 0.30 | 0.07 | 4.29 | 0.002 |
| Instructor Feedback | 0.20 | 0.09 | 2.22 | 0.027 |
| Problem-Solving Skills | 0.12 | 0.06 | 2.00 | 0.045 |
| Time Management | 0.18 | 0.07 | 2.57 | 0.010 |

The MLR was used to analyze how various factors, such as collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management, influence students' overall achievement. By examining these variables, to determine the extent to which each factor contributes to student success, helping to understand their individual and combined effects on academic performance.

### 4.4. Analysis of Variance (ANOVA)

The ANOVA test was employed to ascertain whether various design techniques employed in architectural studios resulted in statistically significant variations in student accomplishment. The use of ANOVA was to determine the influence of different teaching approaches like collaborative learning, iterative processes, instructor feedback, problem-solving skills, and time management on student performance. DF measures the number of independent data points that contribute to the variation in each source. This measures the total variation within each source of variation SS. The given measure of variation per DF is the F-value, which is the ratio of the MS among groups to the MS within groups. Larger effect sizes are often indicated by greater F-values. Statistics are usually considered significant when the p-value is < 0.05. Table **6** displays ANOVA analysis confirmed that certain design approaches, such as collaborative and iterative methodologies, had a significantly stronger impact on student achievement, thereby supporting the use of these teaching strategies in architectural education.

**Table 6: Statistical of ANOVA.**

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square | F-value | P-value |
|---|---|---|---|---|---|
| Between Groups | 180.25 | 4 | 45.06 | 5.12 | 0.002 |
| Collaborative Learning | 50.32 | 1 | 50.32 | 8.46 | 0.003 |
| Iterative Processes | 45.13 | 1 | 45.13 | 7.63 | 0.004 |
| Instructor Feedback | 32.78 | 1 | 32.78 | 5.91 | 0.009 |
| Problem-Solving Skills | 22.65 | 1 | 22.65 | 3.56 | 0.057 |
| Time Management | 29.37 | 1 | 29.37 | 4.89 | 0.017 |
| Within Groups | 950.15 | 521 | 1.82 | - | - |
| Total | 1130.40 | 525 | - | - | - |

By comparing the means of the achievement scores of students among the different groups corresponding to each design methodology, ANOVA helped to determine whether differences in teaching strategies led to statistically significant variations in student outcomes. This method allowed for a strong approach toward assessing the effectiveness of such methodologies in enhancing student creativity, critical thinking, and overall performance.

### 4.5. Paired T-test

The performance of student's before- and after-adoption of particular design techniques in architectural studios can be compared using the paired T-test. When there are two related groups or metrics, such as student performance scores before and after exposure to specific teaching tactics, this statistical test is applicable. Table **5** shows that the assessment of a particular design methodology significantly enhances students' achievement, creativity, or critical thinking skills. Fig. (**4**) shows the Mean before-test Average score before the interference and the mean after-test average score after the intervention. MD measures the difference between the before-test and after-test scores and SD, as well as it measures the spread or variability of the scores. t-value is measuring how the two means differ about the data's variance. Before-test and after-test findings differ more when the t-value is more significant. The percentage of times the observed results occurred by chance is indicated by the P-value. Table **7** and Fig. (**4**) depict the statistically important difference between the before-test and after-test is present when the P-value is < 0.05.

**Table 7: Paired sample t-test results for before-test and after-test means on various educational factors.**

| Factor | Mean Before-Test | Mean After-Test | Mean Difference | Standard Deviation | T-value | Degrees of Freedom | P-value |
|---|---|---|---|---|---|---|---|
| Collaborative Learning | 65.12 | 78.45 | 13.33 | 5.23 | 8.73 | 525 | 0.000 |
| Iterative Processes | 62.87 | 76.90 | 14.03 | 5.10 | 9.10 | 525 | 0.000 |
| Instructor Feedback | 60.50 | 72.10 | 11.60 | 4.80 | 7.65 | 525 | 0.000 |
| Problem-Solving Skills | 58.30 | 70.25 | 11.95 | 4.20 | 8.20 | 525 | 0.000 |
| Time Management | 63.45 | 75.30 | 11.85 | 4.90 | 7.95 | 525 | 0.000 |

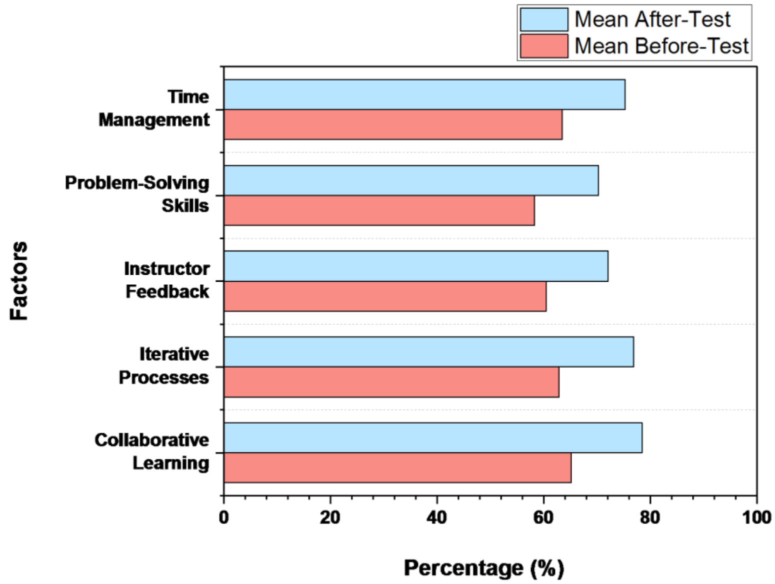



**Figure 4:** Representation of mean before and after-test.

The paired t-test can compare the MD in performance scores with the same group of students to determine whether the observed changes are statistically significant. This analysis provides insights into the effectiveness of different teaching approaches, helping to identify which design methodologies are most beneficial for improving student learning outcomes in architecture education.

### 4.6. Likert Scale

The survey data collected about five key factors related to design methodologies in architecture studios reveals some very insightful patterns regarding students' perceptions. For example, for collaborative learning, the majority of the students agreed, with 40% agreeing and 30% strongly agreeing with collaborative approaches. However, 5% strongly disagreed and 10% disagreed. In terms of iterative processes, 50% agreed, and 30% strongly agreed, showing an overwhelming preference for iterative learning methods, with only 2% strongly disagreeing. The responses for instructor feedback were generally favorable, with 45% agreeing and 25% strongly agreeing, although 3% strongly disagreed. Problem-solving skills were also viewed positively, with 50% agreeing and 25% strongly agreeing, while a small minority (4%) strongly disagreed. Table **8** and Fig. (**5**) show the evaluation of the Likert scale.

**Table 8: Distribution of responses across key learning factors.**

| Factors | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Collaborative Learning | 5% | 10% | 15% | 40% | 30% |
| Iterative Processes | 2% | 8% | 10% | 50% | 30% |
| Instructor Feedback | 3% | 7% | 20% | 45% | 25% |
| Problem-Solving Skills | 4% | 6% | 15% | 50% | 25% |
| Time Management | 5% | 10% | 20% | 40% | 25% |

The time management was less positively received, with 40% agreeing and 25% strongly agreeing but 5% strongly disagreeing, and 10% disagreed, suggesting that although time management is seen as a valuable activity, there can be scope for improvement in its application. Overall, the statistics suggest a strong need for methodologies that encourage collaboration, iteration, and problem-solving, along with the mixed opinions on time management and instructor feedback.

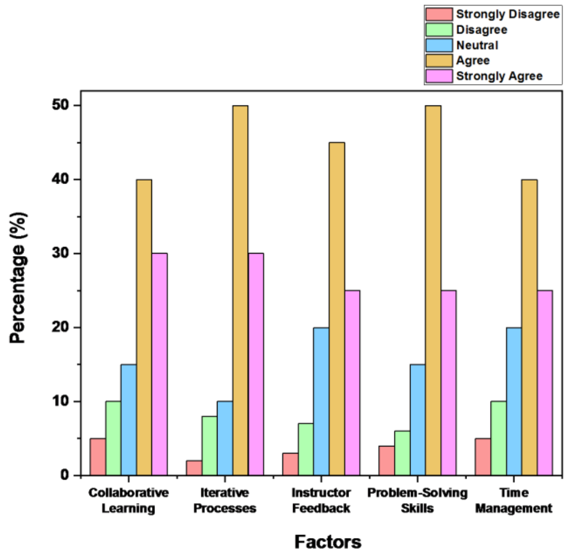



**Figure 5:** Graphical representation of Likert scale.

## 5. Discussion

The design techniques are crucial to students' performance in architectural studios. The significant positive correlations between collaborative learning, iterative processes, and student achievement suggest that the methods not only foster creativity but also enhance critical thinking and problem-solving skills. In general, collaborative learning encourages students to engage with peers, thereby leading to richer, more innovative design solutions. The iterative processes in which students developed their ideas in repeated cycles were found to enhance the quality of their work as well as their ability to think critically and creatively. These methodologies appear to align with the dynamic and evolutionary nature of architectural design, requiring constant reflection and adaptation. The statistical analyses, including correlation coefficient, MLR, ANOVA and paired t-test, further reinforced that these teaching strategies are strong predictors of student success. The research highlights the need for architecture to focus more on these approaches in their curricula to equip students with the technical know-how, as well as the creativity and critical thinking essential for success in the workplace. Results also indicate that instructor feedback and time management are factors, but less so than the collaborative and iterative method for creativity.

## 6. Conclusion

The importance of different design methodologies has been underlined in the accomplishment of students in architecture studios. The research found that cooperative learning and iterative design processes are particularly powerful tools for fostering creativity, critical thinking, and the general overall performance of architecture students. Using statistical analyses of correlation coefficients, MLR, ANOVA and paired t-test confirmed the methodologies as the essential success factors in architectural education. Specifically, collaborative and iterative processes were found to enhance not only the creativity but also the performance of students as an excellent teaching strategy for architectural education. The importance of comments from instructors, problem-solving ability, and time management are highlighted as being of great importance, further extending the multifaceted scope of effective teaching in the context of architectural education. The research suggests to improve architectural design education, educational institutions should adopt these approaches to create more innovative, critical, and performance-oriented learning environments.

## Limitations and Future Research

It is difficult to estimate the long-term effects of design methodologies on student development and achievement beyond the direct context of the research. It can help understand the effectiveness of such teaching strategies in real-world practice beyond academic performance by exploring how the skills and knowledge acquired in architecture studios are transferred to real practice.

## List of Abbreviations

| | | |
|---|---|---|
| MLR | = | Multiple linear regressions |
| ANOVA | = | Analysis of variance |
| CAD | = | Computer aided design |
| BIM | = | Building information modeling |
| VDS | = | Virtual design studios |
| BSGs | = | Business simulation games |
| HOTS | = | Higher-order thinking skills |
| SD | = | Standard deviation |
| MD | = | Mean difference |
| DF | = | Degrees of freedom |
| MS | = | Mean square |
| SS | = | Sum of squares |

## Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Availability of Data and Materials

The datasets used during the current study are available from the corresponding author on request.

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